STEP 1: GOVERNMENT AGENCY CONSULTATION

Coordinate with appropriate agencies before initiating a treatment program. All site characterization/assessment plans, analytical sampling plans, and monitoring plans must be approved by the Alaska Department of Environmental Conservation (ADEC). Always work with agencies to set site-specific short- and long-term goals.

STEP 2: CHARACTERIZE SITE

In order to set treatment goals and identify an appropriate treatment strategy, gather information about the site. Consider the tundra type (Tactic P-2) and important site and spill characteristics. Determine risk to humans and wildlife according to agency requirements.

Tundra Type

The nature and severity of spill impact vary with the tundra type. The high water content of wet tundra soils provides some protection to the root mat from crude oil and fuel spills, which tend to float on the water. Dry tundra soils are highly susceptible to oil-based substances that are absorbed by the dry and porous root mat, displacing the air and making the soil unable to transport water to plant roots. The dry mineral soils in the active layer have the potential to absorb crude oil, fuels, and water-soluble substances. In moist or wet tundra, water can slow the movement of non-water-soluble substances into the soil pore spaces and root mat. In these cases, oiled foliage may be killed, but the roots may survive and grow the following spring.

The sensitivity of different tundra types to the physical impacts of response and treatment tactics differs also. Generally, wet tundra is relatively sensitive to physical damage compared to moist tundra and dry tundra, but recovers more quickly. Dry and moist tundras are less susceptible to physical disturbance but recover more slowly than wet tundra because of the dry conditions, a thin root mat, and very little organic-soil development. The dwarf shrub and lichen communities that occupy dry tundra sites are very slow to recolonize and difficult or impossible to re-establish by seed or transplant techniques. Dry tundra is found in abundance on exposed hilltops and ridges that are subject to extreme wind erosion; such sites present special problems to revegetation. All tundra types are more sensitive to physical and chemical damage when thawed.

Site Layout

The usefulness and practicability of different treatment tactics will depend on the site layout. The availability of road access to the spill site and the limitations to access created by elevated pipelines and other facilities must be considered. A simple map of the site layout should be prepared for planning a treatment strategy (Tactic AM-1). Determine how the natural topographic features and the locations of roads and other facilities can help minimize additional disturbance to the tundra. Identify the routes for mobilizing equipment and materials to the site and areas for waste accumulation. Consider maintenance operations such as snow removal from gravel pads and roads and how these could affect treatment of the site, keeping in mind that treatment may continue for several years.

Site Drainage

Treatment tactics on wet tundra sites must focus on the potential for mobilizing spill residuals into the water and subsequent offsite migration routes. Consider how water would move across the site. Sloped terrain presents a challenge to preventing the downward migration of contamination. Where natural drainage patterns transect the site, temporary diversion of water flow may be required to implement treatment tactics. It is also necessary to plan for future water events, such as spring snowmelt or the rare summer rain shower.

Spill Characteristics

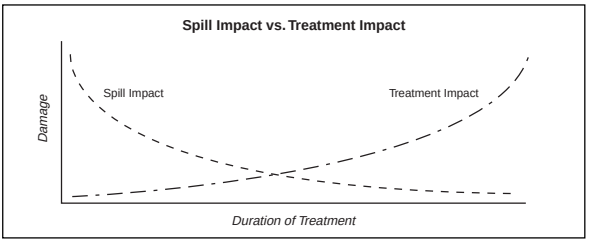
Gain a general understanding of how the spilled substance may affect that environment (Tactic P-3). Use field indicators (Tactic AM-2) to assess the apparent damage caused by the spilled substance. If appropriate, use revegetation test plots (Tactic AM-5) to determine to the extent soil treatments that may be needed. Agencies may also require sampling and laboratory analyses of the soil and water to assess baseline conditions before treatment (Tactic AM-3).

STEP 3: SET TREATMENT GOALS

Using information gained during site characterization, work with the responsible government agencies (including ADEC) to establish site-specific treatment goals before implementing treatment tactics. The general tundra-treatment goals of avoiding and/or minimizing treatment impact and balancing benefits of treatment with physical impact to site should be a guide to setting site-specific goals. Treatment goals may include a combination of reducing the toxicity, volume, and mobility of spill residuals; revegetating the site to agency-acceptable levels within a reasonable time-frame; and preventing thermal effects on tundra soils.

For the following reasons, tundra treatment goals are not always based on a single numerical value of chemical concentration in the soil:

1. ***Tundra is fragile.*** Treatments aimed at achieving state-required chemical concentrations in soils could result in enough physical damage to delay recovery of tundra vegetation or make it impossible. This concept is illustrated in the figure below. Some sites are more fragile than others.
2. ***Different tundra plants have varying tolerance to spill residuals in the soil.*** Low residual levels may adversely affect some species, while others may tolerate higher residual levels. Some sites may be characterized by an abundance of species susceptible to spill residuals, while other sites may be characterized by more spill-tolerant species.
3. ***Soil properties at a site may influence the toxicity of spill residuals to tundra plant species present.*** For example, organic soils may adsorb some of the spilled material, making it less available to plants. For this reason, a particular chemical concentration could be much more toxic to plants in mineral versus organic soils.
4. ***Government agency treatment goals may vary according to the size of the spill and the importance of the site to wildlife and humans.*** Agency goals may also vary from creating an alternate habitat that will support any type of vegetation to restoring the site to original levels of plant species abundance and diversity and ecological function.

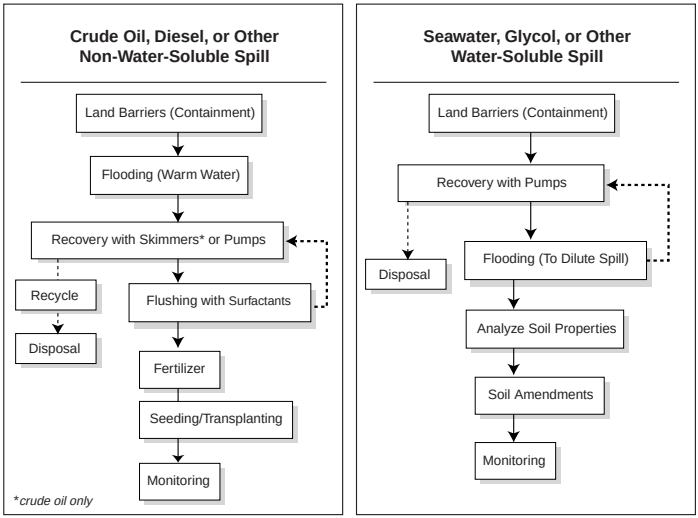


STEP 4: SELECT TREATMENT TACTICS

The treatment tactics in this manual (Tactics T-1 through T-23) describe the applicability of specific tactics, as well as special considerations and limitations. Select tactics to attain the treatment goals while at the same time avoiding excessive damage and induced thermal effects. Some tactics require mobilization of equipment and/or personnel onto the affected tundra surface, which will cause some level of physical damage and the potential for thermokarst. In cases where aggressive tactics are appropriate because of site-specific conditions or goals, design implementation plans to minimize the impact.

STEP 5: ASSEMBLE TACTICS INTO A STRATEGY

A strategy for tundra treatment is basically a group of tactics implemented sequentially. In some cases, certain tactics may be repeated in a cyclic manner until treatment goals have been attained. Review the treatment strategy regularly: Are the treatment goals feasible? Can revegetation occur at the desired rate under present site conditions? Will continued treatment cause more damage than benefit? The example treatment strategies presented in the figures that follow apply to wet, moist, or dry tundra with some seasonal limitations (see individual tactic pages). These example strategies are theoretical; individual site-specific strategies must be developed for each spill to achieve agency-required treatment goals. In general, more stringent treatment goals (e.g., high reduction of spill residuals and revegetation in the short term [2 to 5 years]) will require more aggressive treatment strategies. If a longer time frame for reduction of spill residuals and revegetation is acceptable (i.e., up to 25 years), treatment strategies can be much less aggressive. In some cases, responsible agencies and landowners may determine that "no action" or natural revegetation is the most appropriate strategy.

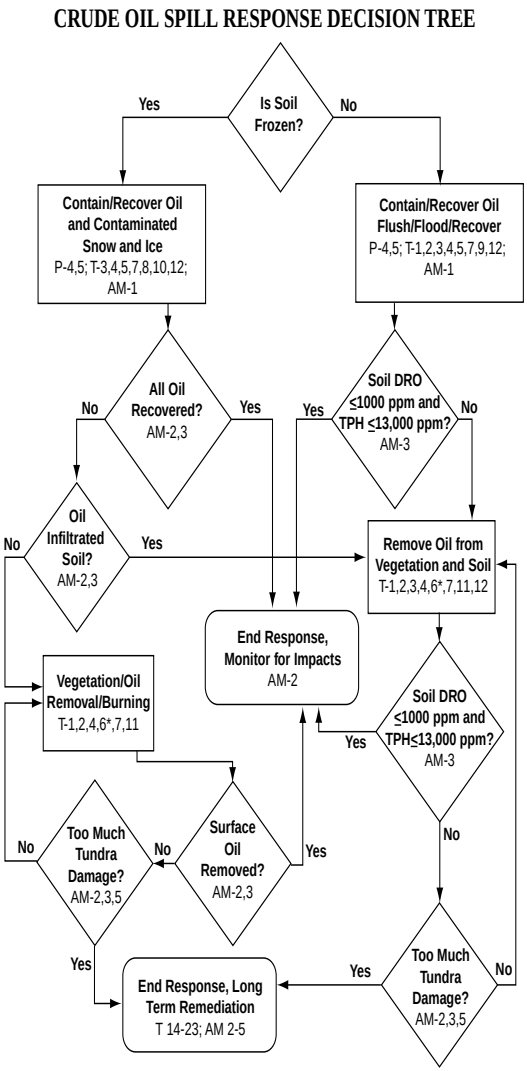


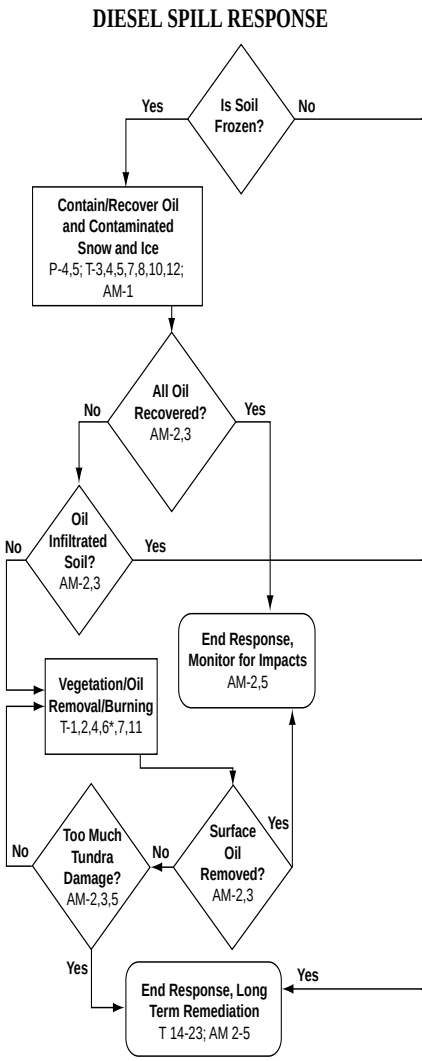
STEP 6: MONITOR TREATMENT AND RECOVERY

Coordinate with responsible government agencies (including ADEC) to prepare a monitoring program to gauge progress and determine when treatment and recovery goals have been reached. Following are possible elements of a monitoring program:

- ***Spill residual monitoring*** during treatment or long-term recovery can be based on sampling and laboratory analysis of soil (Tactic AM-3), field indicators (Tactic AM-2), and apparent phytotoxicity (revegetation test plots [Tactic AM-5]).
- ***Vegetation monitoring*** can be based on the amount of plant cover (percentage of area that plants occupy in a plot of land), the composition of the vegetation, and the condition (Tactic AM-5).
- ***Thermal effects (physical damage) monitoring*** can be based on simple visual observations and documentation of the site topography using ground or aerial photographs.

SAMPLE TUNDRA TREATMENT STRATEGIES

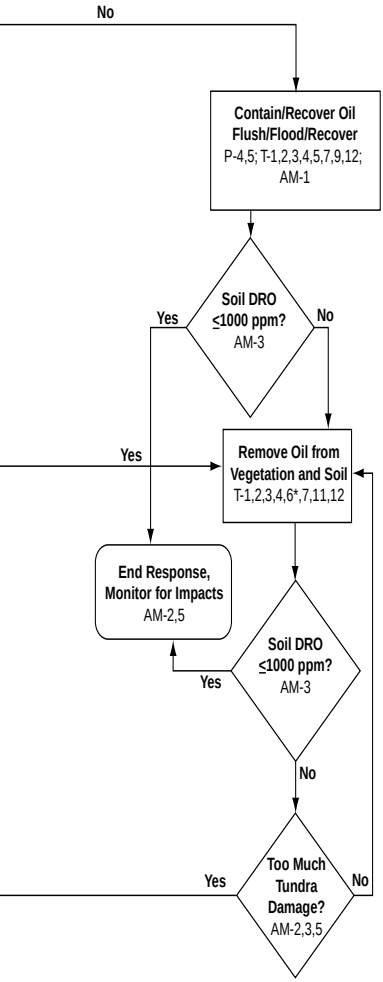




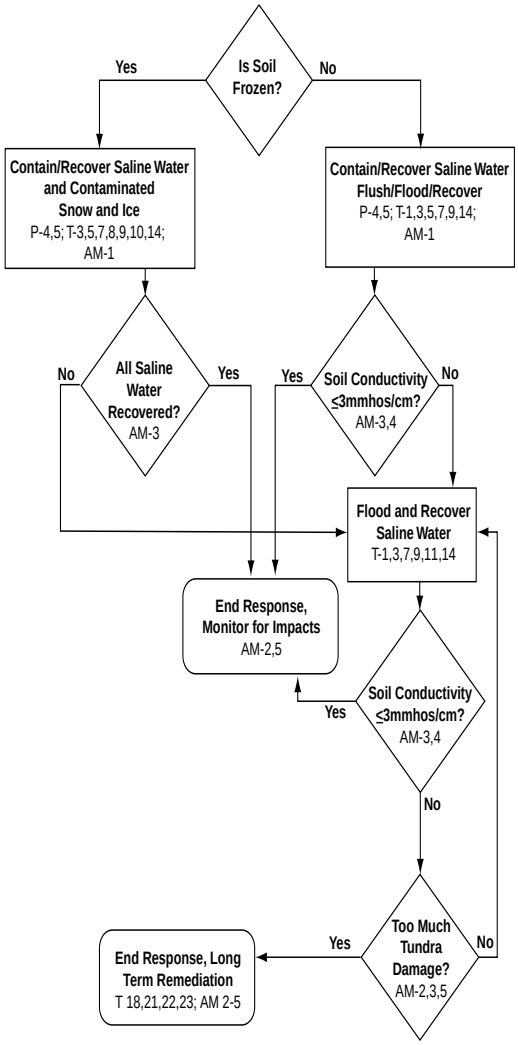
***Permission from ADEC Spill Project Manager must be granted prior to burning.**

SAMPLE TUNDRA TREATMENT STRATEGIES

DECISION TREE



SALINE WATER SPILL RESPONSE DECISION TREE



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